

THE MINERAL INDUSTRY OF SWEDEN

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Sweden is endowed with such natural resources as extensive forests, rich iron ore deposits, and abundant hydroelectric power. In addition to iron ore, the country produced other significant mineral commodities, such as base metals (copper, lead, and zinc) and industrial minerals (dolomite, feldspar, granite, kaolin, limestone, and quartz). Metal mining and metal products manufacturing dominated the mineral industry. Svenskt Stal AB produced high-quality steel for Europe. Sweden's industrialized economy, which is powered by exports and industry, registered a gross domestic product (GDP) growth of 3.5% in 2004. The per capita GDP based on purchasing power parity was \$28,205. Inflation was held low and steady at 1.1%. The country, however, relied heavily on imports of crude petroleum (International Monetary Fund, 2005¹).

Boliden Mineral AB operated seven mines and three ore-concentrating plants at Aitik, Boliden, and Garpenberg. The company's Ronnskar copper and lead smelter treated its own concentrates and purchased concentrates and secondary copper. South Atlantic Ventures Ltd. (renamed Lundin Mining Corp. Ltd.) of Canada operated the Zinkgruvan underground mines and ore-processing plant for the production of zinc and lead concentrates. The Storliden zinc-copper mine was owned by North Atlantic Natural Resources and was operated by Boliden. Production of iron ore was by Luossavaara-Kiirunavaara AB's mines at Kiruna and Malmberget. At Kiruna, output was in the form of pellets and fines and, at Malmberget, pellets and concentrates. Two major limestone producers were Nordkalk AB and Svenska Mineral AB. Cement was produced at three plants operated by Cementa AB (part of the Heidelberg Cement group) (Mining Journal, 2004b).

South Atlantic Ventures reported drill results from the Rakkurijarvi copper/gold discovery zone located in the Kiruna mining district in northern Sweden. A \$1 million exploration drilling program of approximately 5,000 meters (m) was underway with two drill rigs in April. Geophysical survey results indicated that mineralization extended for a strike length of approximately 500 m in a northeast-southwest direction. The mineralization in eight drill holes was characterized by massive, sometimes brecciated, magnetite with stockworks and veins of chalcopyrite and pyrite (South Atlantic Ventures Ltd., 2004).

Ovoca Resources plc of Ireland claimed the Nottjarn concession in northern Sweden in May 2004, and completed reconnaissance geologic mapping and geochemical sampling. There were two different types of mineralization—mesothermal quartz veins and porphyry type copper-gold ore. During May and June, Ovoca Resources undertook a trenching program in the Klippen area that was designed to check the extent of the mineralized zone found by Terra Mining, which reportedly did not extend along the strike. Further mapping and sampling in the southeast of the area outlined a mineralized silicic unit (Ovoca Resources plc, 2004).

Beowulf Gold plc of the United Kingdom began diamond drilling in northern Sweden. The company's joint-venture partner Phelps Dodge Sweden AB completed its first hole of 197 m on the Jokkmokk licenses and planned to drill additional holes. The exploration permits in the Jokkmokk areas covered 82 square kilometers (km²) and were considered prospective for copper and gold mineralization. Beowulf Gold planned to continue drilling on exploration permits in the Grundtraesk area, which covers 43 km² and was considered prospective for gold mineralization (Beowulf Gold plc, 2004[§]).

Exploration activities by Nordic Diamonds Ltd. of Canada on its 100%-owned polymetallic project at Bottenbacken, which is located 490 kilometers (km) northwest of Stockholm in west central Sweden, included geologic mapping, prospecting, and sampling of high-grade mineralized boulders of copper, gold, silver, and palladium content. An induced polarization geophysical survey covering the southeast extension of the mineralized zone was underway. Contingent upon the geophysical survey and geologic reevaluation, a program of trenching and drilling would be undertaken (Nordic Diamonds Ltd., 2004).

North American Gold Inc. of Canada acquired two early-stage properties in the emerging gold-line trend of northern Sweden. The Skarven property covered 2,012 hectares (ha) over a copper-gold target that had been explored previously by the Swedish Geological Survey and Boliden. Skarven is located 18 km southwest of Barsele. The Nasvattnet property covered 969 ha in an area of copper-zinc-silver bearing boulders in glacial till. Nasvattnet is located 35 km southwest of Barsele (North American Gold Inc., 2004a).

North American Gold's exploration activities at the contiguous Barsele and Norra properties in the Vasterbotten District in northern Sweden involved a total of eight drill-tested prospects and multiple untested targets along a northwest strike of some 10 km. The mineral occurrences at Baesele and Norra combined the characteristics of both gold-line trend and volcanogenic massive sulfide. The company completed five diamond drill holes that totaled 1,040 m in the intrusive-hosted central zone. The mineralization at the Norra zone, which is located 2.3 km northwest of the central zone, was open to the northwest toward Cee Lake. North American Gold tested a 2,000-m drilling program in this area in August 2004. Two additional gold occurrences (Risberget and Skirttraskbacken) were located approximately 4 km to the southeast of the central zone. The company initiated a geophysical survey to further enhance the targeting for drilling in these areas. North American Gold had an option to acquire a 60% interest in Baesele and Norra from Minmet plc of Ireland by incurring a total of \$3.5 million in exploration expenditures (North American Gold Inc., 2004b).

Minmet began full in-pit mining at its Bjorkdal gold mine in the Skelleftea District of northern Sweden. Development of the South-East Extension would start ahead of the North Wall pushback. The proven and probable reserves in these two zones were estimated to be 1.26 million metric tons (Mt) at a grade of 2.04 grams per metric ton (g/t) gold. Good continuity of mineralization was defined in the South Wall and Quartz Mountain zones (Minmet plc, 2004).

¹References that include a section mark (§) are found in the Internet References Cited section.

Dragon Mining NL of Australia's 21-hole 1,401-m diamond core-drilling program was focused on the western extensions of the Svartliden mineralization. The drilling confirmed high-grade extensions of the main and northern lodes over a strike length of 270 m. Further drilling of lode extensions to the east and parallel lode extensions was planned (Dragon Mining NL, 2004).

The proven and probable reserves at the Svartliden gold mine were estimated to be 1.6 Mt at a grade of 5.54 g/t gold within a resource base of 2.22 Mt at a grade of 4.54 g/t gold. The Svartliden Mine began production of ore in August. First production of gold was due in October. The mine was expected to produce 2,177 kg of gold during its first year of operation (Mining Journal, 2004a).

Initial drilling by Tertiary Minerals plc of Canada indicated wide intervals of disseminated and semimassive sulfides at its Ahmavuoima project in the Norbotten District in northern Sweden. The iron oxide-copper-gold-type mineralization at Ahmavuoima was thought to be similar to that of the Kiruna deposits. Three mineralization zones were defined by ground geophysics within a 3-km-long magnetic anomaly. Three diamond drill holes were completed in the discovery zone where it showed the weakest mineralization. Drilling was in progress at the central and northwest zones, which featured strong mineralization. Tertiary Minerals also identified another target for the same mineralization at Vehkavarra, which is located 70 km south of Ahmavuoima (Tertiary Minerals plc, 2004§).

Tertiary Minerals began a drilling program to test the zinc-silver mineralization at its Djuragruvan project in the Bergslagen District in south-central Sweden. Three or four holes to a depth of about 100 m were planned. The project would target the historic Gruvberget mining center. The company reviewed the production drilling data from the mine and undertook some geophysical work on the property. The results suggested that the mineralization was open at depth and along the strike (Tertiary Minerals plc, 2004).

Far West Mining Ltd. of Canada began drilling to test nine airborne electromagnetic, magnetic, and base-metal soil geochemical anomalies in the Pitea project area of northern Sweden. A minimum 2,500-m diamond drilling program was to test each of the targets. BHP Billiton granted Far West Mining an option to acquire a 70% interest in the project by completing not less than 4,000 m of diamond drilling by June 30, 2005, and incurring not less than \$1.75 million in expenditures by May 1, 2007 (Far West Mining Ltd., 2004).

Vargon Alloys AB was Sweden's producer of ferrochrome and ferrosilicon. Production required a good supply of electric power, chrome ores, quartz, and reducing agents in the form of coal or coke. Chrome ores came primarily from Albania, Brazil, Madagascar, and Turkey. Quartz was mined for ferrosilicon production from Dalsland County. The company had four electric furnaces. Three furnaces had a combined capacity of from 160,000 to 200,000 metric tons per year (t/yr) of ferrochrome. One furnace produced 25,000 t/yr of ferrosilicon (Vargon Alloys AB, 2004§).

Agricola Resources plc of the United Kingdom was awarded a platinum exploration permit that covered 22.5 km² at Klappsjo, Vasternoorland County in northern Sweden. The permit was centered on the 20-m-thick Klappsjo layered ultramafic intrusion, which showed anomalous platinum values of up to 21 g/t. Aeromagnetic anomalies were located near the high-platinum areas by the Swedish Geological Survey. Diamond drilling in the areas was scheduled to begin in summer 2004 (Agricola Resources plc, 2004§).

Preem's proposed acquisition of Norsk Hydro of Norway's 25% interest in the 200,000-barrel-per-day Scanraff refinery, which would give the company 100% ownership, was approved by the European Commission. Preem planned to implement a \$390 million upgrading project at the facility (Petroleum Economist, 2004).

References Cited

- Dragon Mining NL, 2004, Svartliden gold mine drilling results extend mineralized zone: Perth, Australia, Dragon Mining NL company announcement, March 30, 3 p.
- Far West Mining Ltd., 2004, Far West Mining Ltd. announces that drilling on the BHP Billiton/Far West Mining Pitea silver-lead-zinc project in northern Sweden has commenced: Vancouver, British Columbia, Canada, Far West Mining Ltd. news release, August 13, 2 p.
- Mining Journal, 2004a, Svartliden boost: London, United Kingdom, Mining Journal, June 4, p. 10.
- Mining Journal, 2004b, Sweden—A major miner is born: London, United Kingdom, Mining Journal, September 10, p. 18.
- Minmet plc, 2004, Minmet starts full in-pit mining at Bjorkdal gold mine in Sweden: Dublin, Ireland, Minmet plc press release, August 11, 3 p.
- Nordic Diamonds Ltd., 2004, Exploration update: Vancouver, British Columbia, Canada, Nordic Diamonds Ltd. news release, October 13, 3 p.
- North American Gold Inc., 2004a, North American Gold acquires two new exploration properties in Sweden: Vancouver, British Columbia, Canada, North American Gold Inc. news release, August 3, 1 p.
- North American Gold Inc., 2004b, Update of exploration activities at and barsele and Norra including drilling to commence at Norra August 2, 2004: Vancouver, British Columbia, Canada, North American Gold Inc. news release, July 23, 2 p.
- Ovoca Resources plc, 2004, Good gold grades for Ovoca on Swedish concession: Dublin, Ireland, Ovoca Resources plc company announcement, August 31, 3 p.
- Petroleum Economist, 2004, News in brief: London, United Kingdom, Petroleum Economist, January, p. 41.
- South Atlantic Ventures Ltd., 2004, South Atlantic reports on drill results for the copper-gold Rakkurijarvi discovery zone in northern Sweden: Vancouver, British Columbia, Canada, South Atlantic Ventures Ltd. news release, April 5, 4 p.
- Tertiary Minerals plc, 2004, Tertiary brings modern exploration to Sweden's historic Gruvberget zinc-silver mining center for first time: Cheshire, United Kingdom, Tertiary Minerals plc press release, August 2, 2 p.

Internet References Cited

- Agricola Resources plc, 2004 (April 2), Agricola Resources plc awarded platinum permit at Klappsjo, northern Sweden, accessed April 21, 2004, at URL <http://www.ofex.com/cgi-bin/news.cgi?action=costory&isin=gb0003046835&newsid=19362>.
- Beowulf Gold plc, 2004 (April 13), 2004 drilling campaign started, accessed April 21, 2004, at URL <http://www.ofex.com/cgi-bin/news.cgi?action=costory&isin=gb0033163287&newsid=19392>.
- International Monetary Fund, 2005 (April), Sweden, World Economic Outlook Database, accessed June 2, 2005, via URL <http://www.imf.org/external/pubs/ft/weo/2005/01/data/dbcoutm.cfm>.
- Tertiary Minerals plc, 2004 (April 6), Tertiary encouraged by wide sulfide intersections at Swedish copper-gold target, accessed April 22, 2004, at URL <http://www.tertiaryminerals.com/press060404.htm>.
- Vargon Alloys AB, 2004, Company profile, accessed March 30, 2004, at URL <http://www.vargonalloys.se/eng/equipment.htm>.

Major Source of Information

Geological Survey of Sweden
Mineral Resources Information Office
Skolgatan 4
93070 Mala, Sweden

TABLE 1
SWEDEN: PRODUCTION OF MINERAL COMMODITIES¹

(Metric tons, unless otherwise specified)

Commodity	2000	2001	2002	2003	2004
METALS					
Aluminum, metal:					
Primary	100,800	101,800	100,600	101,200	101,400
Secondary ^c	26,000	25,000	28,000	30,000	29,000
Total	126,800	126,800	128,600	131,200	130,400
Copper:					
Mine output, Cu content	77,765	74,269	72,100	83,100 ^r	85,500
Metal: ^c					
Smelter:					
Primary	95,000	173,000	188,000	185,000	186,000
Secondary	35,000	35,000	35,000	30,000	30,000
Total	130,000	208,000	223,000	215,000	216,000
Refined:					
Primary	105,000	179,000	199,000	189,000	210,000
Secondary	25,000	25,000	25,000	25,000	25,000
Total	130,000	204,000	224,000	214,000	235,000
Gold:					
Mine output, Au content kilograms	3,570	4,986	4,500	4,300	5,300
Metal, primary ^{e, 3} do.	8,000	8,000	8,000	8,000	8,000
Iron and steel, metal:					
Iron ore concentrate and pellets:					
Gross weight thousand metric tons	20,557	19,486	20,300 ^e	21,500 ^e	22,300 ^e
Fe content do.	13,556	12,811	13,400 ^{r, e}	14,100 ^{r, e}	14,700 ^e
Metal:					
Pig iron and sponge iron do.	3,146	3,614	3,703	3,700 ^e	3,600 ^e
Ferroalloys:					
Ferrochromium	135,841	109,198	118,823	110,529 ^r	110,000 ^e
Ferrosilicon ^c	20,000	22,000	23,000	24,000	24,000
Total ^c	156,000	131,000	142,000	135,000 ^r	134,000
Steel, crude thousand metric tons	5,227	5,518	5,754	5,707	5,949
Semimanufactures ^c do.	4,500	4,500	4,600	4,600	4,700
Lead:					
Mine output, Pb content	106,584	85,975	43,000	51,000 ^r	33,900
Metal, refined:					
Primary	30,604	31,322	30,000 ^e	24,200 ^e	30,200 ^e
Secondary	47,255	44,056	39,700 ^e	52,000 ^e	52,000 ^e
Total	77,859	75,378	69,700 ^e	76,200 ^e	82,200 ^e
Molybdenum, oxide, roasted, Mo content ^c	3,000	3,000	3,000	3,000	3,000
Nickel, metal, secondary ^c	50	50	50	50	50
Selenium, elemental, refined ^c	20	20	20	20	20
Silver:					
Mine output, Ag content kilograms	328,737	306,029	293,900 ^r	306,800	292,600
Metal, primary ^{e, 3} do.	250,000	250,000	250,000	250,000	250,000
Zinc, mine output, Zn content	176,788	156,334	148,600	185,900 ^r	160,600
INDUSTRIAL MINERALS					
Cement, hydraulic thousand metric tons	2,651	2,600	2,700 ^e	2,650 ^e	2,700 ^e
Diamond, synthetic ^c thousand carats	20,000	20,000	20,000	20,000	20,000
Feldspar, salable, crude and ground	35,000	40,450	40,000 ^e	41,000 ^e	42,000 ^e
Fertilizer, manufactured: ^c					
Nitrogenous thousand metric tons	400	400	400	400	400
Phosphatic do.	10	10	10	10	10
Mixed do.	300	300	300	300	300
Graphite	5,108	963	900 ^e	850 ^e	800 ^e
Lime ^c thousand metric tons	550	550	580	590	590
Quartz and quartzite ^c do.	500	600	600	600	700

See footnotes at end of table.

TABLE 1--Continued
SWEDEN: PRODUCTION OF MINERAL COMMODITIES¹

(Metric tons, unless otherwise specified)

Commodity	2000	2001	2002	2003	2004
INDUSTRIAL MINERALS--Continued:					
Stone: ^e					
Dimension:					
Mostly unfinished thousand metric tons	160	160	160	170	160
Granite do.	130 ²	128 ²	130	130	130
Limestone do.	32 ²	28 ²	30	32	32
Slate do.	11 ²	16 ²	15	15	15
Other do.	8 ²	5 ²	6	6	6
Crushed:					
Dolomite do.	488 ²	456 ²	450	440	430
Granite do.	3,500	3,500	3,500	3,500	3,500
Limestone:					
For cement manufacture do.	3,770 ²	4,070 ²	4,000	3,950	3,900
For lime manufacture do.	800	900	900	950	950
For other construction and industrial uses do.	1,800	1,800	1,700	1,700	1,700
Chalk:					
For agricultural uses do.	30	70	70	80	80
For other uses do.	450	550	600	650	600
For other uses do.	1,500	1,500	1,500	1,500	1,500
Total do.	8,350 ²	8,890 ²	8,770	8,830	8,730
Sandstone do.	34 ²	5 ²	10	15	20
Undifferentiated do.	30,000	30,000	30,000	30,000	30,000
Other do.	580 ²	371 ²	400	400	350
Sulfur:					
Metallurgy do.	91	152	170 ^{r, e}	235 ^r	235
Petroleum do.	61	55	60 ^e	57 ^r	59
Total do.	152	207	230 ^{r, e}	292 ^r	294
Talc, soapstone	20,000	15,000	15,000 ^e	15,000 ^e	14,000 ^e
MINERAL FUELS AND RELATED MATERIALS					
Coke, metallurgical ^e thousand metric tons	1,200	1,200	1,200	1,250	1,300
Gas, manufactured: ^e					
Coke oven gas million cubic meters	500	500	500	500	500
Blast furnace gas do.	3,500	3,500	3,500	3,500	3,500
Peat:					
Agricultural use ^e thousand cubic meters	1,000	1,400	1,800	1,800	1,100
Fuel do.	1,372	2,496	2,885	2,633 ^r	1,866
Petroleum, refinery products: ^e					
Liquefied petroleum gas thousand 42-gallon barrels	3,000	3,000	3,000	3,000	3,000
Naphtha do.	500	500	500	500	500
Gasoline, motor do.	39,000	40,000	40,000	41,000	41,000
Jet fuel do.	1,500	1,500	1,500	1,600	1,600
Kerosene do.	50	50	50	50	50
Distillate fuel oil do.	57,000	57,000	58,000	58,000	59,000
Residual fuel oil do.	39,000	39,000	40,000	40,000	41,000
Other do.	7,800	7,800	7,800	8,000	8,000
Refinery fuel and losses do.	5,000	5,000	5,000	5,000	5,000
Total do.	153,000	154,000	156,000	157,000	159,000

^eEstimated; estimated data are rounded to no more than three significant digits; may not add to totals shown. ^rRevised.

¹Table includes data available through September 14, 2005.

²Reported figure.

³Includes only that recovered from indigenous ores excluding scrap.

TABLE 2
SWEDEN: STRUCTURE OF THE MINERAL INDUSTRY IN 2004

(Thousand metric tons unless otherwise specified)

Commodity		Major operating companies and major equity owners	Location of main facilities	Annual capacity
Aluminum		Granges AB (Glencore International AG, 100%)	Sundsvall smelter at Kubikenborg	100
Cement		Cementa AB (Scancem, 100%)	Plants at Degerhamn, Skovde, and Slite	3,400
Copper:				
Ore, copper content		Boliden Mineral AB	Mines at Aitik, Garpenberg, Kankberg, Kristineberg, Langdal, Petiknas, and Renstrom	68
Do.		Outokumpu Oyj	Mines at Pahtohavare	22
Metal		Boliden Metals AB	Smelter and refinery at Ronnskar	240
Feldspar		Berglins Malm & Mineral AB (Omya GmbH)	Mines at Beckegruvan, Hojderna, and Limbergsbo	50
Do.		Forshammar Mineral AB (Omya GmbH)	Mines at Limberget and Riddarhyttan	30
Do.		Larsbo Kalk AB (Omya GmbH)	Mines at Glanshamar and Larsbo	20
Ferroalloys		Vargon Alloys AB	Plant at Vargon	175
Gold:				
Ore, gold content	kilograms	International Gold Exploration AB (50%) and Dormant Properties AB (50%)	Bjorkdal Mine at Skellefte	3,000
Do.	do.	Boliden Mineral AB	Mines at Aitik, Akerberg, Kankberg, Kristineberg, Langdal, Petiknas, and Renstrom	2,000
Metal		do.	Smelter and refinery at Ronnskar	9
Graphite		Woxna Graphite AB (Tricorona Mineral AB, 100%)	Mine and plant at Kringeltjarn, Woxna	20
Iron and steel		Svenskt Stal AB (Government, 48%)	Steelworks at Borlange, Lulea, and Oxelosund	3,900
Iron ore		Luossavaara-Kiirunavaara AB (Government, 98%)	Mines at Kiruna and Malmberget	32,500
Kyanite		Svenska Kyanite AB (Svenska Mineral AB, 100%)	Quarry at Halskoberg	10
Lead:				
Ore, lead content		Boliden Mineral AB	Mines at Garpenberg, Laisvall, Langdal, Petiknas, and Renstrom	110
Do.		North Mining Svenska AB	Zinkgruvan Mine at Ammeberg	20
Metal		Boliden Metals AB	Smelter and refinery at Ronnskar	115
Lime		Euroc Mineral AB	Plants at Limham, Koping, and Storugns	250
Do.		Svenska Mineral AB	Plants at Rattvik and Boda	250
Limestone		Kalproduction Storugns AB (Nordkalk AB, 100%)	Mines at Gotland Island	3,000
Marble	cubic meters	Borghamnsten AB	Quarry at Askersund	15,000
Petroleum, refined	42-gallon barrels per day	Skandinaviska Raffinaderi AB	Refinery at Lysekil	210,000
Do.		BP Raffinaderi AB	Refinery at Gothenburg	100,000
Do.		Shell Raffinaderi AB	do.	82,000
Do.		AB Nynas Petroleum	Refineries at Gothenburg, Malmo, and Nynashamn	54,000
Silver, metal	kilograms	Boliden Metals AB	Smelter and refinery at Ronnskar	408,000
Do.	do.	North Mining Svenska AB	Zinkgruvan Mine at Ammeberg	25,000
Zinc, ore, zinc content		Boliden Mineral AB	Mines at Garpenberg, Laisvall, Langdal, and Renstrom	112
Do.		Zinkgruvan Mining AB (North Ltd., 100%)	Zinkgruvan Mine at Ammeberg	60